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LIBOR deception and central bank forward (mis-)guidance: Evidence from Norway during 2007–2011[☆]



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ABSTRACT

This paper is an empirical investigation into the Norwegian Interbank Offered Rate (NIBOR) during 2007–11. It is demonstrated that an informal rule change to the benchmark fixing mechanism, instigated by the NIBOR panel banks, not only increased the susceptibility of the benchmark to deception, but also fundamentally changed the decomposition of the domestic money market risk premium. It resulted in a greater dependency on the Eurozone money markets and the ability of Eurozone banks to raise U.S. dollar funding. As a result, Norway faced both higher, and more volatile, money market risk premia since Q4 2008 – having considerable impact on forward guidance within monetary policy.

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1. Introduction

Recent evidence showing that the London Interbank Offered Rate (Libor),¹ at times, has been subject to manipulation by panel banks have put the integrity of the benchmark into question. Libor-indexed derivatives portfolios, and the stigma attached to signalling a relatively high funding cost to the rest of the market, appear to have given some banks sufficiently strong incentives to submit deceptive Libor quotes in order to reap monetary benefits from having the privilege to participate in the Libor fixing process. The issue has not been confined to that of the Libor alone. A number of equivalent financial benchmarks, such as the Tokyo Interbank Offered Rate (Tibor) and the Euro Interbank Offered Rate (Euribor), have also come under scrutiny from media, regulators, lawyers and academics alike (see Abrantes-Metz et al., 2012; European Commission, 2013; Financial Services Agency, 2011a,b,c; Financial Services Authority, 2012a,b, 2013; Snider and Youle, 2009, 2010; U.S. Commodity Futures Trading Commission, 2012).

However, a deceptive Libor is not only problematic for banks, companies or households having directly entered into financial contracts indexed to the benchmark. The Libor also has an indirect, and broader, impact through the role it plays by acting as a proxy for the short-term interbank money market rate, the key variable in the first stage of the monetary transmission mechanism. Until 2007, this mechanism appeared to have worked more or less as intended, providing support not only to the logic of monetary policy, but to the perception that the Libor was a true reflection of the short-term interbank money market. Surging money market risk premia during the early period of the global financial crisis forced central banks across the world to use their powers to introduce a range of extraordinary measures to alleviate stress in the banking systems. The common expression for these risk premia, the Libor-OIS spread, was widely perceived to be market determined at the time and thus treated as an 'objective fact' (see, for instance, Bank of England, 2007; McAndrews et al., 2008; Poskitt, 2011; Schwartz, 2010; Soltanaeva and Strömqvist, 2009).

The Libor is namely not only supposed to reflect current and expected future repo rates determined by the central bank, but also to contain an element of credit and liquidity risk. This theoretical decomposition is important for central banking, as decisions regarding monetary policy and financial stability can be made, if not with more certainty, at least with greater confidence if the correct signals are obtained from financial market data. Thus, a deceptive signal might complicate policy making more than no signal whatsoever. A substantially understated Libor, for instance, might give central banks the impression that a credit crunch is absent and therefore delay necessary rate cuts, liquidity injections or other accommodative policy measures. An overstated Libor, on the other hand, might act as an unjustified monetary tightening and therefore constrain economic growth.

However, monetary policy is a forward-looking process. What matters the most is not the prevailing central bank policy rate, or indeed the short-term money market rates as expressed in the Libor. Rather, it is the private sector *expectations* of the interest rate and risk premium paths that shape the yield curves and ultimately impact the real economy (Andersson and Hofmann, 2009; Gjedrem, 2006; Rudebusch and Williams, 2008; Svensson, 2006). A range of inflation targeting central banks have gradually come to adopt greater transparency in form of publicly announced inflation and policy rate forecasts in order to make monetary policy more predictable. The Reserve Bank of New Zealand and Norges Bank have gone one step further by also announcing their predicted short-term *money market* rates. Such quantitative forward guidance is supposed to influence market expectations, to make monetary policy more predictable and thus simultaneously increase central bank credibility and reduce financial market volatility. Naturally, interest rate projections made by central banks may differ from market expectations. However, if these projections were reliant upon deceptive market signals, the announcements to the wider public would render themselves meaningless, perhaps even *misguiding*.

¹ List of abbreviations: London Interbank Offered Rate (Libor), Norwegian Interbank Offered Rate (Nibor), Tokyo Interbank Offered Rate (Tibor), Euro Interbank Offered Rate (Euribor), overnight index swap (OIS), covered interest parity (CIP), forward rate agreement (FRA), interest rate swap (IRS), cross-currency basis swap (CRS), Finans Norge (FNO), Euro OverNight Index Average (Eonia), Monetary Policy Committee (MPC), Monetary Policy Report (MPR), Stockholm InterBank Offered Rate (Stibor), Stockholm Tomnext Interbank Average (Stina), Sterling Overnight Interbank Average Rate (Sonia).

Leading central banks such as the Federal Reserve, the Bank of England and the ECB have only very recently moved towards forward guidance in monetary policy, making it difficult to assess the impact of potential Libor and Euribor manipulation on policy decisions. In any case, revealing studies are likely to remain theoretical and hypothetical, rather than empirical, as any deceptive conspiracy is synonymous with a lack of transparency.

Fortunately, there is an exception: Norway. This paper investigates the Norwegian Interbank Offered Rate (Nibor), which underwent a significant and quantifiable, yet ‘secret’ and ‘undocumented’, rule change at the time of the collapse of Lehman Brothers in September 2008. It methodically analyses the link between a benchmark conspiracy and central bank forward guidance during 2007 and 2011 and is organised as follows. Section 2 investigates the susceptibility of the benchmark to manipulation and collusion during this period. It is shown that the rule change, instigated by the Nibor panel banks in September 2008, not only increased the scope for deception of the Norwegian benchmark, but also fundamentally changed the Norwegian risk premium and its decomposition. Section 3 then studies the Norges Bank and uncovers the ramifications of the rule change for central bank policy. Specifically, it empirically assesses the impact on forward guidance. Section 4 concludes.

2. The Nibor

2.1. Background

The Libor, and similar benchmarks for the short-term borrowing cost of banks, is determined by a selected group of panel banks as follows. A designated calculation agent (such as Reuters) collects submitted quotes from the individual panel banks before noon. The trader or other bank person at the cash desk or treasury submits his or her quote from the bank terminal, and the other banks do the same without being able to see each other’s quotes. Then, the calculation agent audits and checks the quotes for obvious errors and then conducts the ‘trimming’, the omission the highest and lowest quotes (the number which depends on the sample size). Finally, the arithmetic mean is calculated, rounded to the specified number of decimals and published at a certain time mid-day depending on the benchmark ([British Bankers Association, 2012](#)).

The Nibor fixing mechanism, however, is unique in so far that it more ‘purely’ reflects the Libor’s historical roots in the Eurocurrency market. When the Nibor was created in the mid 1980s, the Norwegian Eurokrone market was widely regarded as too small and illiquid to serve as a calculation base for a domestic benchmark. Consequently, Nibor panel banks mutually agreed *not* to submit NOK money market rates directly to the Nibor fixing, but to rely on the covered interest parity (CIP). Hence, they decided to submit USD money market rates (in other words the Libor) as well as USD/NOK foreign exchange swaps – thereby forming an *implied* NOK interest rate. As the markets became increasingly liquid over the years, banks found no reason to change this convention as it had been firmly anchored as the benchmark for a range of financial contracts, including new NOK derivatives instruments, such as forward rate agreements (FRAs), interest rate swaps (IRSs) and cross-currency basis swaps (CRSs).

As of today, the Nibor panel consists of six Nordic banks.² The small panel size implies that only two submitted quotes (the highest and the lowest) are omitted from the trimming procedure, and the arithmetic mean is calculated from only four remaining NIBOR quotes. Until 2011, a committee consisting of members from the 6 panel banks informally governed the Nibor. Since 2011, Finans Norge (FNO) acts as the ‘governing body’.³ According to the [FNO \(2011\)](#), the Nibor should reflect ‘*the interest rate level lenders require for unsecured money market lending in NOK*’ and also ‘*which interest rate the bank charges on lending in NOK to a leading bank that is active in the Norwegian money and foreign exchange markets*’. Further, Nibor submissions should be regarded as ‘*best possible estimates, not binding offers*’. Thus, as submissions are indicative, rather than binding, the Nibor can be seen as being subject to equivalent susceptibility to manipulation as other benchmarks.

² Danske Bank, Den Norske Bank, Handelsbanken, Nordea, SEB and Swedbank.

³ In June 2013, a decision was made to transfer the responsibility to the Oslo Stock Exchange.

However, there is technical difference. First, Nibor banks are *not required* to trade at the submitted USD/NOK foreign exchange swap points (one of the two variables making up the Nibor), but are *expected* to be able to do so by other panel members. To be more specific, it is not backed up by a written rule, but by a gentlemen's agreement among the participating banks. Although, according to FNO (2013), the swap points are '*traded in a market that is regarded as liquid*', the mutually agreed foreign exchange swap bid-offer spreads used for the Nibor fixing mechanism are significantly wider than that of the tradable interbank market, making trading at these prices less likely. This naturally increases the probability of (and the expected payoff from) deception on a daily basis to profit from underlying Nibor-indexed portfolios. Nonetheless, anecdotal evidence suggests that a submitted foreign exchange swap rate *outside* this range would normally raise complaints from other panel members, limiting the opportunity to deceive to around 2–10 basis points depending on maturity and prevailing and mutually agreed bid-offer spread.⁴ Whereas this would imply a monetary transfer to one or several of the panel banks from other market participants each day, it could be argued that the impact on of this kind of behaviour on policy making is limited.⁵

The second variable in the Nibor fixing mechanism, namely the USD interest rate, was historically equal to the Libor. However, the global financial crisis came to have a significant impact not only on the Libor as such, but also on its role in the Nibor fixing mechanism. Nordic banks, like their other European peers, faced similar difficulties in raising USD in the Eurodollar markets from mid-2007 – leading to a rush in demand for USD through the foreign exchange swap and cross-currency basis swap markets. As the demand for USD began to rise more than indicated through the Libor, the benchmark came to systematically deviate from the CIP – suggesting that the benchmark significantly *understated* the actual funding cost of the banks. In financial market terms, the cross-currency basis swap, as measured against the USD Libor, turned negative. Fig. 1 depicts this change, using an inverted scale. However, the cross-currency basis swap move was less severe for USD/NOK than for other currency pairs. As Fig. 1 shows, the 3M CRS(Libor^{USD}Nibor^{NOK}) was not only less volatile, but also closer to zero than, for instance, the 3M CRS(Libor^{USD}Euribor^{EUR}) up until September 2008. This should, however, not be interpreted as if the Norwegian money markets were calm, or that Nibor panel banks necessarily found it easier to raise USD funding compared to their peers. Instead, it was a direct result of the differences in the Libor and Nibor fixing mechanisms. Negative cross-currency basis swap spreads indicated that USD term money traded at a premium to the Libor. As the Nibor, *in itself*, was a function both of the Libor and foreign exchange swaps, the relative cost of borrowing in USD in relation to NOK through foreign exchange swaps had a *dampening* effect on Nibor.

Not only was the Libor possibly too low as a result of the manipulation, the Nibor became relatively even more so as 'artificially' cheap NOK could be raised through the foreign exchange swap market, on the condition that Eurodollars were available at Libor. The problem, of course, was that it was unlikely that any bank could raise Eurodollars at Libor, or even come anywhere close. Crucially, the on-going CIP deviation (and particularly prompted by the effects of the Lehman Brothers collapse in September 2008) led the Nibor panel banks to mutually agree to switch from the Libor to what could be regarded as a more 'independent' USD rate for the Nibor calculation. At the time, Nibor panel banks claimed that the USD cash rate published by the broker Carl Kliem was seen as a more accurate and independent rate than the Libor and therefore became used as a starting point. However, it is important to note that as the Nibor completely lacked regulatory oversight at the time, and that this change of rule or convention was 'informal' and undocumented per se until it became common knowledge around 2012.

⁴ A tighter bid-offer spread used for the USD/NOK FX swaps in the fixing mechanism would, ceteris paribus, result in a lower Nibor. Measured in terms of basis points, the bid-offer spread is wider for shorter maturities, implying greater scope for deception for these maturities.

⁵ When comparing data using end-of-day mid-market USD/NOK FX swap points with those of a money market broker (for instance Thomson Reuters page USDNOK3M= with USDNOK3M=TTKL), results show daily differences of several basis points. However, *on average* they have been close (within 1–2 basis points).

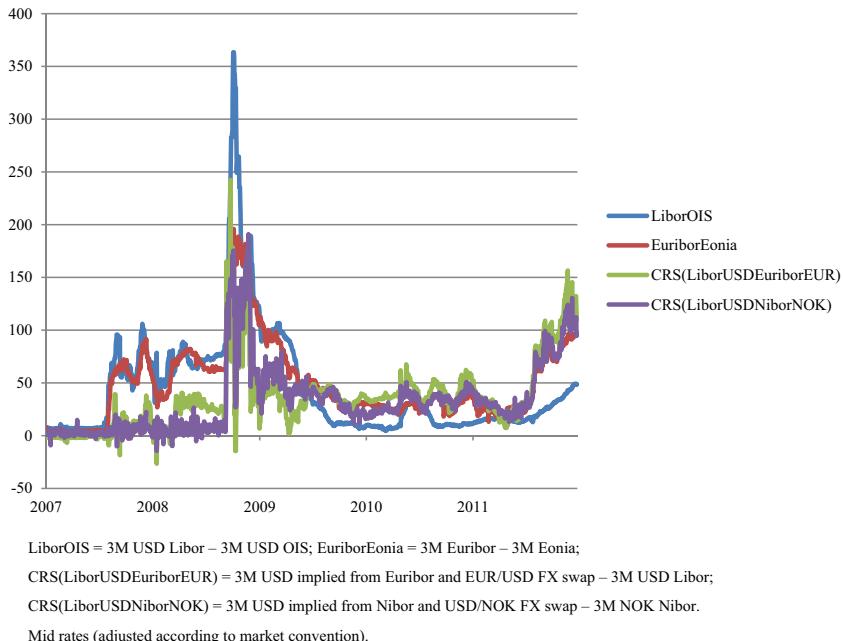


Fig. 1. 3M Libor^{USD}; Euribor^{EUR}; CRS(Libor^{USD}Euribor^{EUR}); CRS(Libor^{USD}Nibor^{NOK}) 2007–2011 (bps).

2.2. Data

Market data in this paper is from Thomson Reuters. More specifically, USD/NOK and EUR/USD FX spot bid rates are from the Reuters multi-contributor page, whereas USD/NOK and EUR/USD FX swap bid rates for 3, 6, 9 and 12 months are from Thomson Reuters (Tullet Prebon). USD cash bid rates for 3, 6, 9 and 12 months are from Thomson Reuters (Carl Kliem/KLIEMMM). Euribor, Libor and Nibor rates for 3, 6, 9 and 12 months are from Thomson Reuters. Eonia, OIS bid rates for 3, 6, 9 and 12 months are from the Reuters multi-contributor page. 5-Year banks CDS spreads, as well as USD, EUR and NOK FRA bid rates from Thomson Reuters DataStream. Where necessary, market data has been adjusted to mid-rates according to the prevailing market conventions. Data from Norges Bank for estimated NOK risk premia, as well as folio rate and money market risk premium projections, are from the data files attached to the Monetary Policy Reports (MPR) of the Norges Bank published in conjunctions with the following Monetary Policy Committee (MPC) meetings: 29 October 2008 (MPR 3/2008), 25 March 2009 (MPR 1/2009), 17 June 2009 (MPR 2/2009), 28 October 2009 (MPR 3/2009), 24 March 2010 (MPR 1/2010), 23 June 2010 (MPR 2/2010), 27 October 2010 (MPR 3/2010), 16 March 2011 (MPR 1/2011), 2 June 2011 (MPR 2/2011) and 19 October 2011 (MPR 3/2011).

2.3. The Nibor rule change

According to FNO (2013), the USD rate in the Nibor fixing mechanism should be '*the rate at which an individual bank argues it can lend unsecured U.S. dollars to the interbank market*'. Banks are neither required to openly disclose which rate is used for the Nibor submission, nor to trade at it. Nonetheless, using the CIP, it is a straightforward process to derive this rate from the Nibor and USD/NOK foreign exchange swap points, which are transparent.

To study the broader ramifications of the change, we first need to establish whether a switch from the Libor actually took place and, if so, what the new variable ('Kliem') entails. This can be

Table 1
Predicting KliemOIS^{USD} using EibOIS^{USD}.^a

	3M KliemOIS ^{USD}	6M KliemOIS ^{USD}	12M KliemOIS ^{USD}
Intercept	−0.0348 [*] (0.0040)	−0.0070 [*] (0.0054)	−0.0601 [*] (0.0096)
EibOIS ^{USD}	1.0189 [*] (0.0053)	1.0047 [*] (0.0058)	1.0203 [*] (0.0082)
Adjusted R square	0.9832	0.9795	0.9609
Observations	633	633	633

Standard errors in parentheses.

* Statistical significance at 99% level.

^a OLS-estimations of equations on 633 observations from 24 July 2009 to 30 December 2011.

done methodically, by extracting four different USD risk premium expressions and conducting simple regression analysis.

We begin by using the standard expression for the money market risk premium (RP), the Libor-OIS spread:

$$RP_t^{CCY} = \text{Libor}_t^{CCY} - \text{OIS}_t^{CCY}, \quad (1)$$

where Libor_t^{CCY} is the prevailing money market benchmark rate and OIS_t^{CCY} the mid-market overnight index swap price (widely used as a proxy for the risk-free rate) for maturity t . Hence, the USD Libor-OIS spread is expressed as:

$$\text{LiborOIS}_t^{\text{USD}} = \text{Libor}_t^{\text{USD}} - \text{OIS}_t^{\text{USD}}, \quad (2)$$

where $\text{Libor}_t^{\text{USD}}$ is the USD Libor and $\text{OIS}_t^{\text{USD}}$ the mid-market USD OIS price for maturity t .

By replacing the benchmark rate with the Kliem USD rate, we get a different expression of the risk premium:

$$\text{KliemOIS}_t^{\text{USD}} = \text{Kliem}_t^{\text{USD}} - \text{OIS}_t^{\text{USD}}, \quad (3)$$

where $\text{Kliem}_t^{\text{USD}}$ is the USD rate published by Carl Kliem for maturity t .

However, as stated on the Carl Kliem Reuters page 'KLIEMMM', the published USD rate is not an observable money market rate per se, but an *implied* USD rate from the EUR cash market (Euribor) and the EUR/USD foreign exchange swap market. In other words, using the CIP, we can derive yet another interest rate expression using the implied USD rate (henceforth named Eib^{USD}) for banks able to borrow at Euribor and swapping them into USD:

$$\text{Eib}_t^{\text{USD}} = \left[\left(1 + \text{Euribor}_t^{\text{EUR}} \times \frac{d_t}{360} \right) \frac{s_t^{\text{EURUSD}}}{f_t^{\text{EURUSD}}} - 1 \right] \times \frac{360}{d_t}, \quad (4)$$

where $\text{Euribor}_t^{\text{EUR}}$ is the EUR Euribor fixing published by Euribor-EBF, s_t^{EURUSD} is the EUR/USD FX spot rate, f_t^{EURUSD} is the EUR/USD FX forward rate and d_t is the number of days for maturity t .

This USD risk premium expression can thus be written as:

$$\text{EibOIS}_t^{\text{USD}} = \left[\left(1 + \text{Euribor}_t^{\text{EUR}} \times \frac{d_t}{360} \right) \frac{s_t^{\text{EUR/USD}}}{f_t^{\text{EUR/USD}}} - 1 \right] \times \frac{360}{d_t} - \text{Ois}_t^{\text{USD}} \quad (5)$$

We can then compare $\text{KliemOIS}_t^{\text{USD}}$ (the USD risk premium using the USD offered rate published by Carl Kliem) with $\text{EibOIS}_t^{\text{USD}}$ (the USD risk premium using the USD offered rate derived from the Euribor and the EUR/USD FX swap market). To test whether the money market broker actually applies this methodology, we run the following regression:

$$\text{KliemOIS}_t^{\text{USD}} = \alpha_t + \beta(\text{EibOIS}_t^{\text{USD}}) + \varepsilon_t \quad (6)$$

The empirical results are shown in Table 1 (see also Fig. 2). As we can see, $\text{EibOIS}_t^{\text{USD}}$ is an almost perfect explanatory variable for the independent variable $\text{KliemOIS}_t^{\text{USD}}$ for the 3, 6 and 12-month maturities (R^2 of 0.983, 0.979 and 0.961 respectively). Small daily deviations are still expected to occur

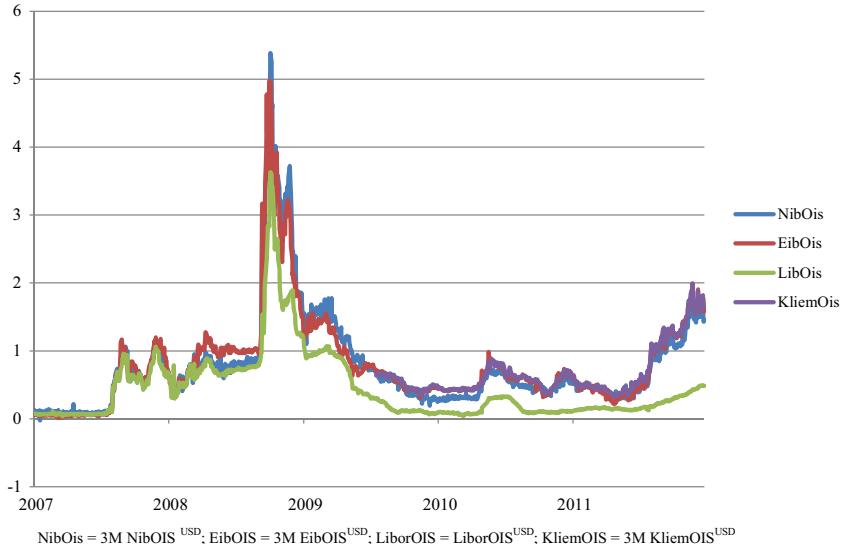


Fig. 2. 3M NibOIS^{USD}; EibOIS^{USD}; LiborOIS^{USD}; KliemOIS^{USD}, 2007–2011 (%).

due to the timing differences between Euribor (mid-day fixing) and Kliem and foreign exchange swaps (end of day quotes). On the whole, this is precisely as we should expect, as the USD rate published by Kliem is, in itself, an implied rate using the Euribor and the prevailing EUR/USD foreign exchange swap rates. The relationship holds firmly throughout the period studied (24 July 2009 to 30 December 2011, for which daily data has been obtained), confirming that the Kliem rate is an implied rate using the CIP. This is analytically important in having a direct impact on the NOK risk premium.

2.4. The impact of the rule change

Having established that the Kliem USD rate is an implied rate using the Euribor and the EUR/USD foreign exchange swap rates enables us to compare the USD rate used in the Nibor fixing mechanism *before* and *after* the rule change.

Let us use Eq. (1) again to express the USD risk premium facing NIBOR panel banks:

$$\text{NibOIS}_t^{\text{USD}} = \text{Nib}_t^{\text{USD}} - \text{OIS}_t^{\text{USD}}, \quad (7)$$

where $\text{Nib}_t^{\text{USD}}$ is the USD rate implied from the Nibor fixing and $\text{OIS}_t^{\text{USD}}$ is the mid-market USD OIS price for maturity t .

As we know that the Nibor fixing mechanism is based upon the CIP, it is a straightforward process to derive the implied USD rate directly from the Nibor fixing and the foreign exchange swap market (henceforth called Nib^{USD}):

$$\text{Nib}_t^{\text{USD}} = \left[\left(1 + \text{Nibor}_t^{\text{NOK}} \times \frac{d_t}{360} \right) \frac{s_t^{\text{USD/NOK}}}{f_t^{\text{USD/NOK}}} - 1 \right] \times \frac{360}{d_t} \quad (8)$$

where $\text{Nibor}_t^{\text{NOK}}$ is the NOK Nibor fixing, $s_t^{\text{USD/NOK}}$ is the USD/NOK foreign exchange spot rate, $f_t^{\text{USD/NOK}}$ is the USD/NOK foreign exchange forward rate and d_t is the number of days for maturity t .

Inserting Eq. (8) into (7) gives us an expression for the USD risk premium facing Nibor panel banks ($\text{NibOIS}_t^{\text{USD}}$):

$$\text{NibOIS}_t^{\text{USD}} = \left[\left(1 + \text{Nibor}_t^{\text{NOK}} \times \frac{d_t}{360} \right) \frac{s_t^{\text{USD/NOK}}}{f_t^{\text{USD/NOK}}} - 1 \right] \times \frac{360}{d_t} - \text{Ois}_t^{\text{USD}} \quad (9)$$

Table 2
[Period I] Pre-Bear Sterns.^a

	3M NibOIS ^{USD}		3M NibOIS ^{USD}
Intercept	0.0194 [*] (0.0038)	Intercept	0.0481 [*] (0.0047)
LiborOIS ^{USD}	1.0523 [*] (0.0080)	EibOIS ^{USD}	0.8721 [*] (0.0087)
Adjusted R square	0.9824	Adjusted R square	0.9703
Observations	309	Observations	309

Standard errors in parentheses.

* Statistical significance at 99% level.

^a OLS-estimations of equations on 309 observations from 9 January 2007 to 14 March 2008.

Consequently, we have now derived four different expressions for the USD risk premium using the same market-determined OIS rate: LiborOIS^{USD}, KliemOIS^{USD}, EibOIS^{USD} and NibOIS^{USD}.

To test whether a rule change actually took place, we run the following regressions for 3-month maturities:

$$\text{NibOIS}_t^{\text{USD}} = \alpha_t + \beta(\text{LibOIS}^{\text{USD}})_t + \varepsilon_t \quad (10)$$

$$\text{NibOIS}_t^{\text{USD}} = \alpha_t + \beta(\text{EibOIS}^{\text{USD}})_t + \varepsilon_t \quad (11)$$

The logic behind choosing 3 months, rather than 6 or 12 months, is two-fold. First, the market liquidity of the former is considerably higher and it is most widely used maturity for the benchmark. Second, the maturity perfectly corresponds to the risk premium projections by the central bank, which will be analysed in Section 3.

The independent variable is NibOIS^{USD} for both regressions (the USD risk premium facing NIBOR panel banks). For the first regression, the explanatory variable is LiborOIS^{USD} (the standard USD Libor-OIS spread). The second regression uses EibOIS^{USD}, the USD rate derived from the Euribor and the EUR/USD foreign exchange swap points, i.e. the risk premium approximation from the Kliem screen (as EibOIS^{USD} ≈ KliemOIS^{USD}). If the Nibor panel banks used the USD Libor for the Nibor fixing prior to the rule change, NibOIS^{USD} and LiborOIS^{USD} ought to have been very closely correlated. After the rule change, however, NibOIS^{USD} should be more closely correlated with EibOIS^{USD}.

Four periods are studied (two prior to, and two after the rule change). Period I (9 January 2007 to 14 March 2008) covers 7 months before, and after, the financial crisis that started in August 2007. Period II (17 March 2008 to 12 September 2008) is the period after the Bear Sterns collapse up until the Lehman Brothers bankruptcy. Period III (15 September 2008 to 3 February 2009) covers the volatile aftermath of the Lehman collapse and the introduction – as well as the extension – of foreign exchange swap arrangements between the Federal Reserve and a number of central banks (including Norges Bank). Even though this episode is fairly short, it is sensible to isolate it due to the extremely volatile market conditions that prevailed. Period IV (4 February 2009 to 31 December 2011) covers the period thereafter.

During Period I (see Table 2 and Fig. 1) both LiborOIS^{USD} and EibOIS^{USD} performed very well as explanatory variables (R^2 of 0.982 and 0.970 respectively). This is not surprising, as the CIP for most currency pairs not only held (almost) perfectly prior to the crisis, but even so up until the collapse of Bear Sterns. Prior to August 2007, all spreads were close to zero. LiborOIS^{USD} and EibOIS^{USD} increased significantly thereafter, whereas both the EUR/USD and USD/NOK cross-currency basis swap (albeit showing increased volatility) remained close to zero. Thus, during the early part of the financial crisis, money market risk premia were fairly well reflected in the cross-currency swaps (or vice versa). The USD Libor was clearly used for the Nibor fixing mechanism.

The EUR/USD cross-currency basis swap begins to deviate after the collapse of Bear Sterns (Period II). This marks the beginning of the ‘Dollar Premium’ and the breakdown of the CIP. To put it differently, the Libor no longer reflected the USD rate as expressed in the foreign exchange swap markets. Cross currency swaps (quoted against the USD) in other currencies also began to deviate from the CIP, but interestingly the USD/NOK cross-currency basis swap remained close to zero – in effect giving the

Table 3[Period II] Pre-Lehman Brothers.^a

	3M NibOIS ^{USD}		3M NibOIS ^{USD}
Intercept	0.0366 [*] (0.0493)	Intercept	0.3582 [*] (0.0690)
LiborOIS ^{USD}	0.9171 [*] (0.0670)	EibOIS ^{USD}	0.4453 [*] (0.0680)
Adjusted R square	0.5906	Adjusted R square	0.2448
Observations	130	Observations	130

Standard errors in parentheses.

^{*} Statistical significance at 99% level.^a OLS-estimations of equations on 130 observations from 17 March 2008 to 12 September 2008.**Table 4**[Period III] Post-Lehman Brothers.^a

	3M NibOIS ^{USD}		3M NibOIS ^{USD}
Intercept	0.4111 ^{**} (0.1051)	Intercept	0.1529 [*] (0.0779)
LiborOIS ^{USD}	1.3073 [*] (0.0548)	EibOIS ^{USD}	1.0110 ^{**} (0.0285)
Adjusted R square	0.8491	Adjusted R square	0.9257
Observations	102	Observations	102

Standard errors in parentheses.

^{*} Statistical significance at 95% level.^{**} Statistical significance at 99% level.^a OLS-estimations of equations on 102 observations from 15 September 2008 to 3 February 2009.

(false) impression of the non-existence of a Dollar Premium among Nibor panel banks. However, from the perspective of the Nibor fixing mechanism, it was working properly as it was supposed to imply a cross-currency basis swap close to zero.⁶ Instead, the ‘Libor error’ was directly imported to the Nibor – meaning that for every basis point the USD Libor understated the ‘actual’ funding cost (as expressed in the cross-currency basis swap market), the Nibor decreased by the same magnitude. Empirically (see Table 3), the relationship to EibOIS^{USD} breaks down during this period (the intercept having increased from 0.048 to 0.358 and \bar{R}^2 decreased to 0.245). The explanatory power of the LiborOIS^{USD} is still fairly strong ($\bar{R}^2 = 0.591$), although weakened from the previous period, probably due to a combination of factors: first, this was a volatile period in the markets, and the timing differences mattered more, and second: Nibor panel banks began to become uncertain with regards to the accuracy and reliability of the Libor, and possibly began taking steps in adjusting the rates to reflect this. The intercept increased from 0.019 to 0.137 (1.9 and 13.7 basis points respectively).

The empirical results for the aftermath of the collapse of Lehman Brothers (Period III) need to be analysed with a high degree of caution. The period was remarkably volatile, and the implied interest rates showed movements of several hundred basis points during a number of trading days. Despite this, the results (Table 4) show that NibOIS^{USD} is now more correlated with EibOIS^{USD} ($\bar{R}^2 = 0.926$) than with LiborOIS^{USD} ($\bar{R}^2 = 0.849$). It confirms that a rule change indeed took place at the time of the collapse of Lehman Brothers, or that a few banks adopted a change that others quickly followed.

Finally, Period IV (see Table 5) demonstrates that, as the markets recovered somewhat, EibOIS^{USD}, having replaced LiborOIS^{USD}, continued to be a good indicator for the USD risk premium used by Nibor panel banks ($\bar{R}^2 = 0.910$). Importantly, EibOIS^{USD} (and therefore NibOIS^{USD}) is consistently higher than LiborOIS^{USD} throughout this period, and especially so during the times of uncertainty with regards to the Eurozone crisis (around May 2010 and from mid-2011 onwards). We will return to this observation in Section 3.

⁶ The implied CRS basis is normally calculated using Libor, Nibor and the mid FX swap points. Therefore, as long as the bid-offer spread for USD/NOK FX swaps is greater than zero, the basis will be negative. Prior to the crisis, the USD/NOK CRS was normally around -6 effectively implying an implied bid-offer spread in the FX swap market of 12 basis points.

Table 5
[Period IV] Post-Euro.^a

	3M NibOIS ^{USD}		3M NibOIS ^{USD}
Intercept	0.3165 [*] (0.0108)	Intercept	-0.0363 [*] (0.0092)
LiborOIS ^{USD}	1.3662 [*] (0.0303)	EibOIS ^{USD}	0.9971 [*] (0.0115)
Adjusted R square	0.7293	Adjusted R square	0.9095
Observations	755	Observations	755

Standard errors in parentheses.

* Statistical significance at 99% level.

^a OLS-estimations of equations on 755 observations from 4 February 2009 to 30 December 2011.

In sum, the empirical evidence presented here suggests that the Nibor panel banks did replace the Libor with the Kliem USD rate at the time of the Lehman Brothers bankruptcy, after arguing that the Libor no longer reflected the actual USD interbank funding cost. However, after closer scrutiny we can conclude that this rate is not ‘independent’ either, as the indication (Kliem^{USD}) is an implied rate also, namely from the Euribor and the EUR/USD foreign exchange swap points – expressing the cost of Eurozone banks borrowing at Euribor and swapping them into USD.

3. Norges Bank

3.1. The ‘New’ Norwegian risk premium

Despite the worsening credit situation and the global liquidity concerns appearing in 2007, the domestic inflation outlook led Norges Bank to maintain a fairly hawkish stance with regards to monetary policy well into 2008. The collapse of Lehman Brothers, however, saw a sharp reversal in this policy, prompting large rate cuts and liquidity injections similar to those of other central banks. Norges Bank also entered into swap facilities with the Federal Reserve to address the elevated pressures in USD short-term funding markets.

Although the reported level of the USD funding cost faced by Nibor panel banks is of interest for Norges Bank, it is the *domestic* NOK risk premium that is of greater concern for monetary policy and the Norwegian economy. Norges Bank was an early adopter of inflation targeting and has been at the forefront with regards to transparency and quantitative forward guidance. Since 2005, it publishes its own projected repo rate paths, and since October 2008 also its own money market risk premium projections based on 3-month Nibor in conjunction with every Monetary Policy Report (MPR). Its most important monetary policy instrument is the *folio* rate, which is the interest rate on banks deposits in Norges Bank. This influences the Nibor, the first observable step in the monetary transmission mechanism, as well as the key underlying benchmark for the majority of forward-looking interest rate derivative instruments.

To discuss the ramifications of the rule change upon central bank policy, let us first compare the ‘old’ (before the rule change) with the ‘new’ (after the rule change) Norwegian risk premium both theoretically and empirically. For this purpose, we return to Eq. (1) to express the Norwegian risk premium as:

$$RP_t^{\text{NOK}} = \text{Nibor}_t^{\text{NOK}} - \text{Nois}_t^{\text{NOK}}, \quad (12)$$

where $\text{Nibor}_t^{\text{NOK}}$ is the NOK Nibor and $\text{Nois}_t^{\text{NOK}}$ represents the *theoretical* NOK overnight index swap rate (the daily compounded current and expected future repo rates) for maturity t , as no such market yet exists in the currency. Using the OIS as a risk-free rate (whether it is tradable or purely theoretical) enables us namely to decompose the Nibor into specific components.

Next, using the OIS (rather than the Libor) as benchmark rates, the deviation from the CIP can be written as:

$$\text{CRS}(\text{OIS}^{\text{CCY2}} \text{OIS}^{\text{CCY1}})_t = \text{OIS}_t^{\text{CCY2}} - \left[\left(1 + \text{OIS}_t^{\text{CCY1}} \times \frac{d_t}{360} \right) \frac{f_t^{\text{CCY1/CCY2}}}{s_t^{\text{CCY1/CCY2}}} - 1 \right] \times \frac{360}{d_t} \quad (13)$$

Hence, for NOK against USD as:

$$\text{CRS}(\text{Nois}^{\text{NOK}} \text{OIS}^{\text{USD}})_t = \text{Nois}_t^{\text{NOK}} - \left[\left(1 + \text{OIS}_t^{\text{USD}} \times \frac{d_t}{360} \right) \frac{f_t^{\text{USD/NOK}}}{s_t^{\text{USD/NOK}}} - 1 \right] \times \frac{360}{d_t}, \quad (14)$$

where $\text{CRS}(\text{Nois}^{\text{NOK}} \text{OIS}^{\text{USD}})_t$ is the cross-currency basis swap using 'Nois' (the theoretical Norwegian OIS) for NOK and OIS for USD.

Inserting Eq. (14) into (7) gives us a close approximation of the 'old' Nibor (which was based upon the Libor):

$$\text{Nibor}(\text{old})_t^{\text{NOK}} \approx \text{Libor}_t^{\text{USD}} + (\text{Nois}_t^{\text{NOK}} - \text{OIS}_t^{\text{USD}}) - \text{CRS}(\text{Nois}^{\text{NOK}} \text{OIS}^{\text{USD}})_t, \quad (15)$$

Consequently, the 'old' NOK risk premium can be decomposed into two separate components:

$$\text{RP}(\text{old})_t^{\text{NOK}} \approx \text{Libor}_{\text{OIS}}_t^{\text{USD}} - \text{CRS}(\text{Nois}^{\text{NOK}} \text{OIS}^{\text{USD}})_t \quad (16)$$

The first component is the standard USD Libor-OIS spread and the second component, $\text{CRS}(\text{Nois}^{\text{NOK}} \text{OIS}^{\text{USD}})_t$, is the cross-currency basis swap as measured against *risk-free* interest rates (rather than benchmark rates such as Nibor and Libor as the market convention implies).

As demonstrated in Section 2, the rule change altered the composition of the NOK risk premium when the Libor was replaced by the Kliem USD rate. By changing the USD rate in Eq. (15), the 'new' Nibor equation (after the rule change) can be written as:

$$\text{Nibor}(\text{new})_t^{\text{NOK}} \approx \text{Kliem}_t^{\text{USD}} + (\text{Nois}_t^{\text{NOK}} - \text{OIS}_t^{\text{USD}}) - \text{CRS}(\text{Nois}^{\text{NOK}} \text{OIS}^{\text{USD}})_t \quad (17)$$

However, anecdotally, as well as empirically demonstrated, we also know that Kliem is not a perfectly independent rate either. Rather, it is a derivation from the Euribor and the prevailing cross currency basis swap between EUR and USD:

$$\text{Kliem}_t^{\text{USD}} \approx \left[\left(1 + \text{Euribor}_t^{\text{EUR}} \times \frac{d_t}{360} \right) \frac{s_t^{\text{EURUSD}}}{f_t^{\text{EURUSD}}} - 1 \right] \times \frac{360}{d_t} \quad (18)$$

Next, following Eq. (13), the cross currency basis swap for EUR against USD using OIS can be written as:

$$\text{CRS}(\text{Eonia}^{\text{EUR}} \text{OIS}^{\text{USD}})_t = \text{Eonia}_t^{\text{EUR}} - \left[\left(1 + \text{OIS}_t^{\text{USD}} \times \frac{d_t}{360} \right) \frac{f_t^{\text{USD/EUR}}}{s_t^{\text{USD/EUR}}} - 1 \right] * \frac{360}{d_t} \quad (19)$$

where $\text{CRS}(\text{Eonia}^{\text{EUR}} \text{OIS}^{\text{USD}})_t$ is the cross-currency basis swap using Eonia (Euro OverNight Index Average) for EUR and OIS for USD – quantifying the relative demand for USD versus EUR (derived from the FX swap market) expressed in a basis point spread as measured against the risk-free tradable OIS and Eonia markets. Eqs. (18) and (19) give us:

$$\text{Kliem}_t^{\text{USD}} \approx \text{Euribor}_t^{\text{EUR}} - (\text{Eonia}_t^{\text{EUR}} - \text{OIS}_t^{\text{USD}}) + \text{CRS}(\text{Eonia}^{\text{EUR}} \text{OIS}^{\text{USD}})_t \quad (20)$$

Therefore, by inserting Eq. (20) into (17), we get an expression of the 'new' NOK risk premium:

$$\text{RP}(\text{new})_t^{\text{NOK}} \approx \text{Euribor}_{\text{Eonia}}_t^{\text{EUR}} + \text{CRS}(\text{Eonia}^{\text{EUR}} \text{OIS}^{\text{USD}})_t - \text{CRS}(\text{Nois}^{\text{NOK}} \text{OIS}^{\text{USD}})_t \quad (21)$$

where $\text{Euribor}_{\text{Eonia}}_t^{\text{EUR}}$ is the standard Euribor-Eonia spread and $\text{CRS}(\text{Eonia}^{\text{EUR}} \text{OIS}^{\text{USD}})_t$ is the cross-currency basis swap using Eonia for EUR and OIS for USD – quantifying the relative demand for USD versus EUR as measured against the risk-free tradable OIS and Eonia markets.

3.2. A non-technical interpretation

We have now derived two expressions for the decomposed Norwegian money market risk premium, each consisting of market-observable, and theoretical, variables. The differences are striking. Prior to the rule change (Eq. (16)) the NOK risk premium had two drivers: the USD Libor-OIS spread and the cross-currency swap between Nois and OIS. In other words, the risk premium as reported by Libor panel banks was directly ‘imported’ to Norway, regardless of its accuracy or appropriateness as a proxy for the USD funding cost of Nibor panel banks. From the perspective of central bank policy, we see that a repo rate adjustment by the Federal Reserve or Norges Bank (or market expectations of such) would have no direct effect on the risk premium. Instead, the premium was determined by the Libor panel bank’s assessment of the USD risk premium (which, however, the Federal Reserve might be able to influence *indirectly*).

The cross-currency basis swap component is market-determined, but also subject to possible intervention by both central banks. A NOK liquidity injection, for instance, would reduce the risk premium, whereas relatively easier access to USD funding would increase the risk premium (as it would make NOK relatively more expensive). Consequently, unless the Libor fully reflects the demand for USD as expressed in the foreign exchange or cross-currency swap market (i.e. if the CIP does not hold), the NOK risk premium will be under- or overstated by the same magnitude. As the empirical results show, the fixing mechanism based upon this principle worked well up until around the collapse of Bear Sterns in March 2008. However, it broke down with the rise of the Dollar Premium, when the Libor no longer fully reflected the price banks were prepared to pay as expressed in the foreign exchange swap and cross-currency swap market. This suggests that the Norwegian risk premium was somewhat *understated* during the period between the collapse of Bear Sterns and that of Lehman Brothers in 2008.

The dynamics of the NOK risk premium changed fundamentally as a result of the rule change (Eq. (21)). First, the Libor is no longer ‘relevant’ and the Libor-OIS spread has instead been replaced by the Euribor-Eonia spread. This is important, as it could be argued that the Euribor is less prone to manipulation due to its larger panel size (43 banks at the time). However, the Euribor has not managed to escape allegations of systematic manipulation either, so this argument is weak. It could also be claimed that the Euribor-Eonia spread is a more appropriate measure for the NOK risk premium than the Libor-OIS spread due to the closer similarity of the banking systems as a whole. To be more specific, it could be argued that the EUR risk premium expressed by banks mainly in the Eurozone is a better proxy for Norway than is the USD risk premium stated by a more international panel in London. Problematically though, as the recent Eurozone crisis has shown, the Euribor panel contains a number of banks whose funding costs hardly are representative of a typical Nibor panel bank. Moreover, the problems faced, and measures taken, by the European Central Bank have differed significantly from those of the Norges Bank since 2010.

Second, with regards to the cross-currency basis swap, the impact of the USD/NOK swap market remains the same. However, whereas a domestic USD funding squeeze, or a NOK liquidity injection, previously would have a dampening effect on the risk premium, the new explanatory variable, CRS(Eonia^{EUR}OIS^{USD}), works the opposite way – and is completely outside the remit of Norges Bank. Now, a USD funding squeeze among Eurozone banks (or a EUR liquidity injection by the European Central Bank) would – *ceteris paribus* – *increase* the NOK risk premium.

In sum: despite having decoupled from potential issues with the accuracy of the Libor fixing, the Nibor now relies upon the accuracy of the Kliem rate, which in turn depends on the Euribor (and the accuracy of it), and the perceived health of the Eurozone banking system. Moreover, whereas the CRS component previously could be influenced by Norges Bank and/or the Federal Reserve, a completely new actor has entered the arena: the European Central Bank.

3.3. Risk premium projections and forward guidance

Fluctuating money market risk premia do not necessarily need to be damaging if their causes are well understood and appropriate offsetting policy measures are available. However, decisions are not made on an ad hoc basis, but are forward-looking. Therefore, a fundamental change in the way the risk

premium is derived ought to influence the way the central bank makes its forecasts – and accordingly its decisions with regards to monetary policy and financial policy.

Naturally, repo rate and risk premium projections by central banks might differ from prevailing market expectations. Indeed, as Svensson (2006) notes, the central bank should strive to lead and influence market expectations, rather than mechanically follow them. Nonetheless, they are closely connected, as the central bank policy rate affects the short-term money market rates (as observed in the Libor). The latter then impacts the *expected* future money market rates (as observed in the Libor-indexed FRA and IRS markets), as well as other long term rates – which in turn influence domestic economic output and inflation. Therefore, if the drivers of the risk premium are altered as a result of a sudden rule change, they should not only influence the current and expected future risk premia in the financial markets, but also the central bank's assessment of these.

To investigate whether this has been the case, we first conduct an empirical investigation of the impact of the Nibor rule change upon the difference between market expectations and the projections by Norges Bank between 2008 and 2011. We then look for potential patterns of inconsistency in the communication.

To analyse the projected NOK risk premia as assessed by Norges Bank, let us first define:

$$\Delta RP_{t+1}^{NOK(NB)} = RP_{t+1}^{NOK(NB)} - RP_t^{NOK(NB)}, \quad (22)$$

where $\Delta RP_{t+1}^{NOK(NB)}$ is the difference between the *projected* risk premium average for period $t+1$ and the *actual* risk premium (according to the Norges Bank's calculation method) for day t .

Returning to Eq. (21), we know that the 'new' NOK risk premium can be decomposed into three 'drivers', namely the Euribor–Eonia spread, the CRS(Eonia^{EUR}OIS^{USD}) and the CRS(Nois^{NOK}OIS^{USD}). As the first two variables are observable, we can work out how the market priced and projected them at the time of each MPR:

$$\Delta \text{EuriborEonia}_{t+1}^{\text{EUR}} = \text{EuriborEonia}_{t+1}^{\text{EUR}} - \text{EuriborEonia}_t^{\text{EUR}} \quad (23)$$

$$\Delta \text{CRS}(\text{Eonia}^{\text{EUR}}\text{OIS}^{\text{USD}})_{t+1} = \text{CRS}(\text{Eonia}^{\text{EUR}}\text{OIS}^{\text{USD}})_{t+1} - \text{CRS}(\text{Eonia}^{\text{EUR}}\text{OIS}^{\text{USD}})_t, \quad (24)$$

where $\Delta \text{EuriborEonia}_{t+1}^{\text{EUR}}$ is the difference between the market Euribor–Eonia spread (using EUR FRAs and forward-forward Eonia) for day $t+1$ and the actual market Euribor–Eonia spread for day t . $\Delta \text{CRS}(\text{Eonia}^{\text{EUR}}\text{OIS}^{\text{USD}})_{t+1}$ is the difference between the market implied cross-currency basis swap (using forward-forward USD OIS, EUR Eonia and EUR/USD foreign exchange swaps) for day $t+1$ and the market implied cross-currency basis swap for day t .

However, as there is no NOK OIS market, a 'theoretical Nois' needs to be constructed to account for the third component: the CRS(Nois^{NOK}OIS^{USD}), which measures the demand for USD relative to NOK in OIS-terms. Problematically, the central bank does not openly disclose the precise method of its estimation, but bases it upon market interest rates, interviews with market participants and 'judgement', which includes comparisons with risk premia in other currencies and foreign exchange swap rates (Hellum and Kárvík, 2012). For the sake of comparison, let us simply assume that the remaining component *should* equal the residual of the NOK risk premium calculated by the central bank minus the two observable variables:

$$\Delta \text{CRS}(\text{Nois}^{\text{NOK}}\text{OIS}^{\text{USD}})_{t+1} \approx \Delta RP_{t+1}^{NOK(NB)} - \Delta \text{EuriborEonia}_{t+1}^{\text{EUR}} - \Delta \text{CRS}(\text{Eonia}^{\text{EUR}}\text{OIS}^{\text{USD}})_{t+1} \quad (25)$$

3.4. Empirical results

Having established that the Nibor rule changed altered the mathematical decomposition of the risk premium (and thereby also how it should be forecast), let us now study the impact empirically.

The net impact of the Nibor rule change on the NOK risk premium can be quantified by subtracting Eq. (16) from (21):

$$RP(\text{new})_t^{\text{NOK}} - RP(\text{old})_t^{\text{NOK}} \approx -\text{LiborOIS}_t^{\text{USD}} + \text{EuriborEonia}_t^{\text{EUR}} + \text{CRS}(\text{Eonia}^{\text{EUR}}\text{OIS}^{\text{USD}})_t \quad (26)$$

By using daily market data, we can derive each component in Eq. (26). Table 6 displays a breakdown, and the net impact, of the rule change at the time of each MPR. A 5-day moving average is applied

Table 6Impact of the Nibor rule change on the 3M NOK risk premium.^a

MPR	MPR date	LiborOIS ^{USD}	EuriborEonia ^{EUR}	CRS(Eonia ^{EUR} OIS ^{USD})	Net impact
3/2008	29.10.08	-2.970	1.659	1.578	0.267
1/2009	25.03.09	-1.061	0.893	0.510	0.342
2/2009	17.06.09	-0.402	0.413	0.248	0.259
3/2009	28.10.09	-0.114	0.266	0.154	0.307
1/2010	24.03.10	-0.056	0.278	0.163	0.385
2/2010	23.06.10	-0.313	0.306	0.496	0.489
3/2010	27.10.10	-0.106	0.216	0.158	0.267
1/2011	16.03.11	-0.160	0.211	0.222	0.273
2/2011	22.06.11	-0.129	0.189	0.122	0.181
3/2011	19.10.11	-0.303	0.718	0.512	0.927

Sources: Thomson Reuters Datastream and author's own calculations.

^a 5-day moving averages (expressed in %).**Table 7**3M RP^{NOK(NB)} (Risk Premia assessed by Norges Bank in its Monetary Policy Reports (MPR)).^a

MPR	Estim.	Next calendar quarters			Projected averages			Projected Δ		
3/2008	1.79	Q1/09	Q2/09	Q3/09	1.11	0.62	0.53	-0.68	-1.17	-1.26
1/2009	1.15	Q2/09	Q3/09	Q4/09	1.01	0.86	0.84	-0.14	-0.29	-0.31
2/2009	0.89	Q3/09	Q4/09	Q1/10	0.60	0.59	0.57	-0.29	-0.30	-0.32
3/2009	0.51	Q1/10	Q2/10	Q3/10	0.36	0.31	0.28	-0.15	-0.20	-0.23
1/2010	0.35	Q2/10	Q3/10	Q4/10	0.32	0.28	0.26	-0.03	-0.07	-0.09
2/2010	0.65	Q3/10	Q4/10	Q1/11	0.58	0.50	0.43	-0.07	-0.15	-0.22
3/2010	0.55	Q1/11	Q2/11	Q3/11	0.43	0.47	0.41	-0.12	-0.08	-0.14
1/2011	0.55	Q2/11	Q3/11	Q4/11	0.55	0.50	0.40	0.00	-0.05	-0.15
2/2011	0.55	Q3/11	Q4/11	Q1/12	0.45	0.35	0.30	-0.10	-0.20	-0.25
3/2011	0.94	Q1/12	Q2/12	Q3/12	0.75	0.65	0.60	-0.19	-0.29	-0.34

Sources: Norges Bank and author's own calculations.

^a 5-day moving averages (expressed in %). Estim. = 3M NOK risk premium estimated by Norges Bank.

to match the calculation date, rather than the publication date, of the central bank assessments and projections.

As the table demonstrates, the rule change caused an overall jump in the 3-month NOK risk premium by around 30 bps. Two observations stand out in particular. The first period is around the publication of MPR 2/2010, when the CRS(Eonia^{EUR}OIS^{USD}) spread strongly contributed to a net impact of 48.9 bps. The second period is around MPR 3/2011, when the EuriborEonia^{EUR} spread spiked to 71.8 bps, resulting in a total rule change impact of almost a full percentage point (92.7 bps). Considering that Norges Bank most frequently adjusts its repo rate in 25 bps increments, the effect is significant. Notably, both periods perfectly coincide with periods of severe Eurozone stress and uncertainty.

In order to study these overall observations closer, and particularly their relation to quantitative forward guidance, we need to systematically compare central bank projections with market projections.

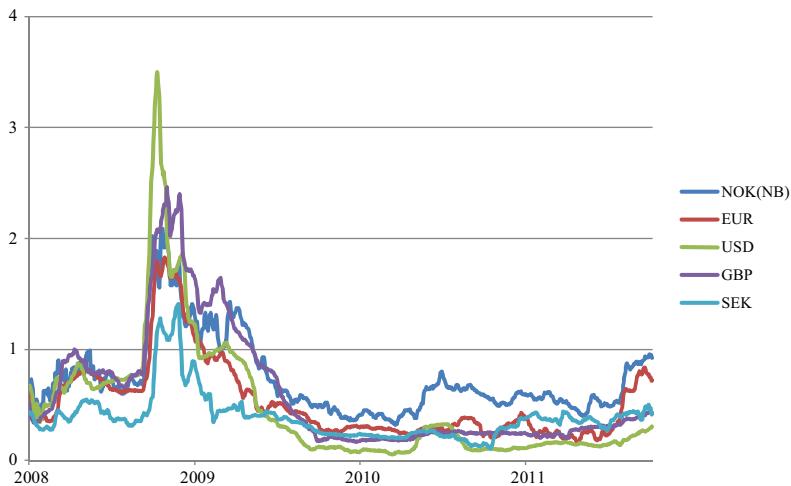
We begin by looking into the forward guidance provided by Norges Bank in conjunction with each Monetary Policy Report. Table 7 shows the estimated current and projected future 3M NOK risk premia for the next three calendar quarters – as well as the projected change of the risk premium as expressed in Eq. (22).

Although projections for several years forward are provided in each Monetary Policy Report, we restrict ourselves to the projections for the three next calendar quarters for two reasons. First, central banks should arguably be considerably more accurate in short-term, rather than long-term, quantitative forward guidance. Second, the financial instruments used for the variables in Eqs. (23) and (24) are liquid and observable for maturities up to one year, whereas the liquidity and data frequency drops significantly thereafter. Comparisons beyond one year are therefore likely to become speculative and subject to data and interpolation issues.

Table 83M RP^{NOK(NB)} (Risk Premia assessed by Norges Bank in its Monetary Policy Reports (MPR)).^a

MPR	Estim.	Next calendar quarters			Actual RP averages		Actual versus projections		
3/2008	1.79	Q1/09	Q2/09	Q3/09	1.21	1.03	0.57	0.10	0.41
1/2009	1.15	Q2/09	Q3/09	Q4/09	1.03	0.57	0.43	0.02	-0.29
2/2009	0.89	Q3/09	Q4/09	Q1/10	0.57	0.43	0.40	-0.03	-0.16
3/2009	0.51	Q1/10	Q2/10	Q3/10	0.40	0.52	0.67	0.04	0.21
1/2010	0.35	Q2/10	Q3/10	Q4/10	0.52	0.67	0.55	0.20	0.39
2/2010	0.65	Q3/10	Q4/10	Q1/11	0.67	0.55	0.57	0.09	0.05
3/2010	0.55	Q1/11	Q2/11	Q3/11	0.57	0.49	0.71	0.14	0.02
1/2011	0.55	Q2/11	Q3/11	Q4/11	0.49	0.71	—	-0.06	0.21
2/2011	0.55	Q3/11	Q4/11	Q1/12	0.71	—	—	0.26	—
3/2011	0.94	Q1/12	Q2/12	Q3/12	—	—	—	—	—

Sources: Norges Bank and author's own calculations.

^a 5-day moving averages (expressed in %). Estim. = 3M NOK risk premium estimated by Norges Bank.

NOK (NB) = Norges Bank's own NOK risk premium estimate; EUR = 3M Euribor-Eonia; USD = 3M Libor-OIS; GBP = 3M Libor-Sonia;
SEK = 3M Stibor-Stina.

Fig. 3. 3M Money market risk premia 2008–2011 (%).

Further, Table 8 shows the actual quarterly risk premium averages as assessed by Norges Bank (once known) and the difference vis-à-vis the projections in the past.

Three observations are notable from Tables 7 and 8. First, as illustrated also in Fig. 3, Norges Bank consistently assessed the NOK risk premium to be *higher* than most of its main trading partners since 2009 (apart from a brief spell in 2009 when the GBP risk premium was higher).

Second, Norges Bank projected, without exception, a *narrowing* of the NOK risk premium over time.⁷

Third, since MPR 3/2009, Norges bank was generally *too optimistic* with regards to the development of the NOK risk premium. Importantly, these differences were largest around the time of Eurozone stress and uncertainty.

Before reflecting upon these three observations, let us turn to the projections by market participants. We use the following methodology. Using daily market data for 3 month Euribor and Libor; 3X6, 6X9 and 9X12 EUR FRAs; 3, 6, 9 and 12 month Eonia and OIS; and 3, 6, 9 and 12 month EUR/USD FX swap

⁷ This also holds for risk premium projections further out (the Monetary Policy Reports provide projected risk premium paths that stretches out several years).

Table 9
3M EuriborEonia^{EUR} spreads (linear interpolation).^a

MPR	Actual	Next calendar quarters			Market projections			Market projected Δ		
3/2008	1.66	Q1/09	Q2/09	Q3/09	0.65	0.40	0.32	-1.01	-1.26	-1.34
1/2009	0.89	Q2/09	Q3/09	Q4/09	0.78	0.66	0.65	-0.11	-0.23	-0.24
2/2009	0.41	Q3/09	Q4/09	Q1/10	0.41	0.41	0.36	-0.00	0.00	-0.05
3/2009	0.27	Q1/10	Q2/10	Q3/10	0.26	0.27	0.30	-0.01	-0.00	0.03
1/2010	0.28	Q2/10	Q3/10	Q4/10	0.23	0.22	0.25	-0.05	-0.06	-0.03
2/2010	0.31	Q3/10	Q4/10	Q1/11	0.35	0.36	0.35	0.04	0.05	0.04
3/2010	0.22	Q1/11	Q2/11	Q3/11	0.28	0.25	0.25	0.06	0.03	0.03
1/2011	0.21	Q2/11	Q3/11	Q4/11	0.26	0.27	0.28	0.05	0.06	0.07
2/2011	0.19	Q3/11	Q4/11	Q1/12	0.21	0.24	0.26	0.02	0.05	0.07
3/2011	0.72	Q1/12	Q2/12	Q3/12	0.59	0.48	0.50	-0.13	-0.24	-0.22

Sources: Thomson Reuters Datastream and author's own calculations.

^a 5-day moving averages (expressed in %).

Table 10
3M EuriborEonia^{EUR} spreads (cubic spline interpolation).^a

MPR	Actual	Next calendar quarters			Market projections			Market projected Δ		
3/2008	1.66	Q1/09	Q2/09	Q3/09	0.61	0.39	0.32	-1.05	-1.27	-1.34
1/2009	0.89	Q2/09	Q3/09	Q4/09	0.78	0.65	0.65	-0.11	-0.24	-0.24
2/2009	0.41	Q3/09	Q4/09	Q1/10	0.40	0.42	0.37	-0.01	0.01	-0.04
3/2009	0.27	Q1/10	Q2/10	Q3/10	0.26	0.26	0.30	-0.01	-0.01	0.03
1/2010	0.28	Q2/10	Q3/10	Q4/10	0.22	0.22	0.25	-0.06	-0.06	-0.03
2/2010	0.31	Q3/10	Q4/10	Q1/11	0.35	0.37	0.35	0.04	0.06	0.04
3/2010	0.22	Q1/11	Q2/11	Q3/11	0.28	0.25	0.25	0.06	0.03	0.03
1/2011	0.21	Q2/11	Q3/11	Q4/11	0.26	0.27	0.27	0.05	0.06	0.06
2/2011	0.19	Q3/11	Q4/11	Q1/12	0.21	0.24	0.26	0.02	0.05	0.07
3/2011	0.72	Q1/12	Q2/12	Q3/12	0.58	0.47	0.50	-0.14	-0.25	-0.22

Sources: Thomson Reuters Datastream and author's own calculations.

^a 5-day moving averages (expressed in %).

rates, we derive daily market projections for the 3M risk premium variables 3, 6 and 9 months forward for the period studied. For each Monetary Policy Report, we then calculate market projections for the 3M risk premium variables for the next three calendar quarters using linear interpolation. Again, a 5-day moving average is applied in order to match the central bank methodology. For the sake of robustness, we also conduct a separate calculation using a cubic spline interpolation method. Finally, the projections for the quarterly averages are calculated.

Using the expression in Eq. (23), the empirical results are displayed in Table 9.

We can see that from mid-2010, the market consistently predicted slightly higher 3M Euribor-Eonia spreads for the next three quarters. The notable exception was around MPR 3/2011 in October 2011, when the spread was already highly elevated (72 bps).

As can be seen from Table 10, the application of a cubic spline interpolation method changes the results only minimally.

Table 11 compares the actual change in the quarterly averages of the 3M Euribor-Eonia spreads with the market (linear) projections in the past. Despite predicting higher spreads from mid-2010, the market under-, rather than overestimated, the severity of the Eurozone crisis.

A similar pattern can be seen from Table 12, using Eq. (24) to depict the relative demand for USD versus EUR in OIS-terms.

At the time of publication of every single monetary policy report since 2010, the financial markets predicted an increasing difficulty for Eurozone banks to raise funding in USD. Notably, this was even the case when the cross currency spreads were already highly elevated (such as around MPR 2/2010 and MPR 3/2011). Again, a cubic spline interpolation method does hardly alter the empirical results (Table 13).

However, a comparison between market (linear) projections and actual outcomes yields more mixed results (Table 14). The negative outlook that prevailed around MPR 2/2010 was followed by

Table 113M EuriborEonia^{EUR} spreads.^a

MPR	Actual	Next calendar quarters			Actual Δ		Actual versus lin. projections			
3/2008	1.66	Q1/09	Q2/09	Q3/09	-0.70	-1.09	-1.22	0.31	0.17	0.11
1/2009	0.89	Q2/09	Q3/09	Q4/09	-0.32	-0.45	-0.61	-0.21	-0.23	-0.37
2/2009	0.41	Q3/09	Q4/09	Q1/10	0.03	-0.13	-0.12	0.03	-0.13	-0.08
3/2009	0.27	Q1/10	Q2/10	Q3/10	0.02	-0.00	0.06	0.03	-0.00	0.03
1/2010	0.28	Q2/10	Q3/10	Q4/10	-0.01	0.05	0.01	0.04	0.11	0.04
2/2010	0.31	Q3/10	Q4/10	Q1/11	0.02	-0.02	-0.04	-0.02	-0.08	-0.08
3/2010	0.22	Q1/11	Q2/11	Q3/11	0.05	0.00	0.31	-0.01	-0.03	0.28
1/2011	0.21	Q2/11	Q3/11	Q4/11	0.01	0.32	0.65	-0.04	0.26	0.58
2/2011	0.19	Q3/11	Q4/11	Q1/12	0.34	0.67	0.32	0.62		
3/2011	0.72	Q1/12	Q2/12	Q3/12						

Sources: Thomson Reuters Datastream and author's own calculations.

^a 5-day moving averages (expressed in %).**Table 12**3M CRS(Eonia^{EUR}OIS^{USD}) spreads (linear interpolation).^a

MPR	Actual	Next calendar quarters			Market projections		Market projected Δ			
3/2008	1.58	Q1/09	Q2/09	Q3/09	0.63	0.27	0.11	-0.95	-1.31	-1.47
1/2009	0.51	Q2/09	Q3/09	Q4/09	0.65	0.76	0.73	0.14	0.25	0.22
2/2009	0.25	Q3/09	Q4/09	Q1/10	0.28	0.32	0.34	0.03	0.07	0.09
3/2009	0.15	Q1/10	Q2/10	Q3/10	0.11	0.12	0.08	-0.04	-0.03	-0.07
1/2010	0.16	Q2/10	Q3/10	Q4/10	0.18	0.18	0.19	0.02	0.02	0.03
2/2010	0.50	Q3/10	Q4/10	Q1/11	0.55	0.57	0.56	0.05	0.07	0.06
3/2010	0.16	Q1/11	Q2/11	Q3/11	0.18	0.24	0.24	0.02	0.08	0.08
1/2011	0.22	Q2/11	Q3/11	Q4/11	0.23	0.26	0.27	0.01	0.04	0.05
2/2011	0.12	Q3/11	Q4/11	Q1/12	0.16	0.20	0.21	0.04	0.08	0.09
3/2011	0.51	Q1/12	Q2/12	Q3/12	0.56	0.57	0.53	0.05	0.06	0.02

Sources: Thomson Reuters Datastream and author's own calculations.

^a 5-day moving averages (expressed in %).**Table 13**3M CRS(Eonia^{EUR}OIS^{USD}) spreads (cubic spline interpolation).^a

MPR	Actual	Next calendar quarters			Market projections		Market projected Δ			
3/2008	1.58	Q1/09	Q2/09	Q3/09	0.60	0.26	0.11	-0.98	-1.32	-1.47
1/2009	0.51	Q2/09	Q3/09	Q4/09	0.66	0.78	0.74	0.15	0.27	0.23
2/2009	0.25	Q3/09	Q4/09	Q1/10	0.28	0.32	0.34	0.03	0.07	0.09
3/2009	0.15	Q1/10	Q2/10	Q3/10	0.11	0.13	0.09	-0.04	-0.02	-0.06
1/2010	0.16	Q2/10	Q3/10	Q4/10	0.19	0.18	0.19	0.03	0.02	0.03
2/2010	0.50	Q3/10	Q4/10	Q1/11	0.55	0.57	0.56	0.05	0.07	0.06
3/2010	0.16	Q1/11	Q2/11	Q3/11	0.18	0.25	0.24	0.02	0.09	0.08
1/2011	0.22	Q2/11	Q3/11	Q4/11	0.23	0.27	0.27	0.01	0.05	0.05
2/2011	0.12	Q3/11	Q4/11	Q1/12	0.16	0.20	0.21	0.04	0.08	0.09
3/2011	0.51	Q1/12	Q2/12	Q3/12	0.56	0.59	0.53	0.05	0.08	0.02

Sources: Thomson Reuters Datastream and author's own calculations.

^a 5-day moving averages (expressed in %).

a contraction in the CRS(Eonia^{EUR}OIS^{USD}) spread. On the other hand, the market underestimated the risk of a return of the Dollar Premium in late 2011.

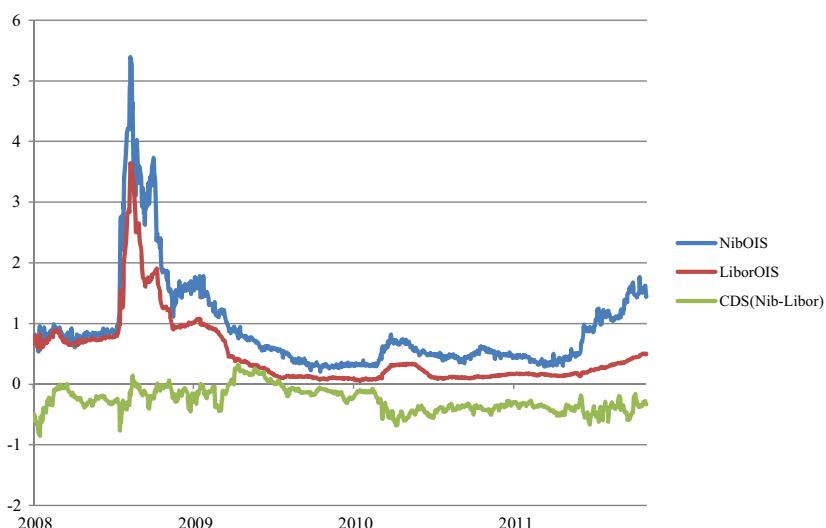
In sum, we can conclude that financial markets during this period had, quite understandably, a negative outlook with regards to risk premia in the Eurozone. Both risk premium measures indicated stress and uncertainty, and the markets predicted higher spreads going forward. Still, market participants underestimated the risk of a worsening financial crisis somewhat.

From Eq. (25), we know that this should, ceteris paribus, also have had an influence on the risk premium projections by the Norges Bank. However, the empirical results paint a conflicting picture.

Table 143M CRS(Eonia^{EUR}OIS^{USD}) spreads.^a

MPR	Actual	Next calendar quarters			Actual Δ			Actual versus lin. projections		
3/2008	1.58	Q1/09	Q2/09	Q3/09	-1.14	-1.26	-1.35	-0.19	0.05	0.13
1/2009	0.51	Q2/09	Q3/09	Q4/09	-0.19	-0.28	-0.37	-0.33	-0.53	-0.58
2/2009	0.25	Q3/09	Q4/09	Q1/10	-0.02	-0.11	-0.11	-0.04	-0.18	-0.20
3/2009	0.15	Q1/10	Q2/10	Q3/10	-0.01	0.23	0.13	0.03	0.26	0.20
1/2010	0.16	Q2/10	Q3/10	Q4/10	0.22	0.12	0.07	0.20	0.10	0.03
2/2010	0.50	Q3/10	Q4/10	Q1/11	-0.22	-0.27	-0.27	-0.27	-0.34	-0.34
3/2010	0.16	Q1/11	Q2/11	Q3/11	0.07	-0.05	0.15	0.05	-0.13	0.08
1/2011	0.22	Q2/11	Q3/11	Q4/11	-0.11	0.09	0.42	-0.13	0.05	0.37
2/2011	0.12	Q3/11	Q4/11	Q1/12	0.19	0.52		0.16	0.44	
3/2011	0.51	Q1/12	Q2/12	Q3/12						

Sources: Thomson Reuters Datastream and author's own calculations.

^a 5-day moving averages (expressed in %).NibOIS = 3M NibOIS^{USD}; LiborOIS = 3M LiborOIS^{USD};

CDS (Nib-Libor) = Average 5Y CDS spread for NIBOR panel banks – Average 5Y CDS spread for LIBOR panel banks.

Fig. 4. 3M NibOIS^{USD}; 3M LiborOIS^{USD}; 5Y CDS (Nib-Libor) 2008–2011 (%).

Throughout the period after the rule change, Norges Bank consistently projected *lower* domestic risk premia, whereas the market predicted unchanged, or even *higher*, risk premia in the Eurozone.

For this to be justified, in other words for the equation to hold, Norges Bank ought to have had a *specific* view on the third and final component (the USD/NOK cross-currency basis swap market) that deviated significantly from market expectations. It is natural that central bank projections differ from market expectations. If so, however, the discrepancy ought to be consistent with the verbal communication by the central bank in conjunction with the MPC meetings during this period.

Three options are possible. First, the projections by Norges Bank could have included an assessment that the Nibor panel banks, over time, would face relatively more severe USD funding pressures than the Eurozone banks. This would, *ceteris paribus*, dampen the risk premium through the cross-currency basis swap component. This, however, is improbable as even though the Eurozone crisis had some spill-over effects on the Norwegian banking system, the overall effects were considerably more contained, not least evidenced by the Norges Bank itself in regarding it unnecessary to reintroduce the FX swap lines with the Federal Reserve. Moreover, as Fig. 4 shows (depicting the spread between the average

5-year CDS spreads of the Libor and Nibor panels respectively), the Nordic banks belonging to the panel were generally perceived as relatively creditworthy throughout the crisis.

Second, the optimistic risk premium projections by the central bank could have been derived from a view that more accommodative liquidity provisions in NOK would become necessary. Added NOK liquidity would namely have an impact upon the foreign exchange swap market and hence the cross-currency basis swap – thus justifying a downward sloping risk premium path. This, again, is highly unlikely. Instead, the opposite view appears to have been prominent among Norges Bank officials, as highlighted in the following statement by the central bank governor in 2010:

'[...] It would appear that banks have grown accustomed to dealing directly with the central bank instead of redistributing liquidity in the interbank market'... It makes banks passive. The market for short-term unsecured liquidity becomes very limited or disappears. The pricing mechanism – or the rates set in the money market – contains information that will not emerge if a public actor such as the central bank takes the market's place. Consequently, we now need to set clearer boundaries between the central bank's role as lender of last resort and settlement bank and the role of the market.' ([Gjedrem, 2010](#)).

Consequently, it appears as if even though the NOK risk premium projections ought to have been more influenced by risk premia in the Eurozone, Norges Bank put more emphasis on other factors in their projections: either that the financial markets and other central banks consistently overstated the problems in the Eurozone (very unlikely), or that it regarded the USD rate used in the Nibor fixing as too high for Norwegian banks. In other words, the central bank could have – knowingly or unknowingly of its relevance for the fixing mechanism – doubted the validity of the Kliem USD rate and incorporated some kind of ‘correction’. However, Norges Bank appears to have focussed on the Nibor as a ‘fact’, rather than on the technical components generating it:

'During the financial crisis, risk premiums (money market rates less expected key policy rate over the same horizon) were generally higher in Norway than in other countries. They have also remained higher in Norway than in other countries in the post-crisis period.'... Premiums have remained high and volatile over the past year and are above what can be assumed to be a normal level. High premiums are an indication that the money market in Norwegian kroner is functioning poorly.' ([Norges Bank, 2010](#)).

As has been theoretically and empirically demonstrated in this paper, the higher and more fluctuating Norwegian risk premium was not a result of the (mal)functioning of the domestic money market at all, but the product of a change in the components generating the Nibor.

4. Conclusions

The empirical study in this paper demonstrates that a rule change to the Nibor fixing mechanism took place in September 2008, after the Libor appeared to have lost its reliability as an unbiased reflection of the actual funding cost of banks. Although some kind of change probably was warranted, the decision about the timing and the new rule was reached through consensus among the members of the Nibor panel only. The rule change was informal, secret and undocumented, in the sense that the Nibor was a self-governed benchmark by the Nibor committee (consisting of the six panel banks), and no written documentation or information about the actual change (or the contents of it) was required to be disclosed to any other parties – despite its crucial importance for the financial markets and the wider public. It could be argued that the perception of level of the money market rate was not dictated by the central bank or the market as a whole, but by a conspiracy of a fairly small number of commercial banks until it became common knowledge several years later.

It is difficult to judge whether the rule change actually benefitted the panel banks monetarily as relevant bank-level data is confidential. However, there is no doubt that it catered for greater scope of Nibor manipulation by individual panel banks. Considering the higher volatility and the fairly complex mathematical derivation (not to mention the complete lack of requirement to trade at submitted quotes), systematic deviations from it can be more easily justified than from the previous Libor.

Regardless, it has been clearly demonstrated that the rule change immediately came to have a significant impact on the decomposition of the Norwegian risk premium. It resulted in higher domestic risk premia and significantly greater dependency on developments and the health of the banking system in the Eurozone, as well as the policy action by the European Central Bank. In addition, whenever the Dollar Premium has been more elevated in the Eurozone than in Norway, as it has been during times of Eurozone stress, this has been reflected in an *additional* NOK risk premium. Consequently, when Eurozone banks were seen to be under pressure (both during late spring 2010 and in the second half of 2011), the problems were not only imported to the NOK risk premium, they became *magnified* as a result of the new Nibor fixing mechanism.

Any deceptive signal transmitted through the Nibor could cause the central bank to make a wrong, delayed or hastened decision – having an impact for the economy as a whole. Furthermore, a deceptive decomposition methodology of the benchmark could cause the quantitative forward guidance by the central bank to become misguided. The empirical study in this paper suggests that the Nibor, as a result of its direct link to the Libor, understated the Norwegian risk premium from the early days of the global financial crisis up until September 2008. After the rule change, the risk premium was (sometimes considerably) higher and more volatile – arguably more so than could have been justified. Moreover, the fundamental change in the Nibor fixing mechanism should also have changed the way the central bank shapes its risk premium forecasts. The results shown here suggest that this did not take place.

Seen from an international political economy perspective, the results are worrying. Whereas the Nibor seems to have been *understated* during the early days of the financial crisis (as an immediate outcome of an artificially low Libor) and *overstated* thereafter (as a result of the new methodology), it implicitly suggests that systematic ‘low-ball’ing of the Libor, Euribor, etc. could have delayed central bank policy measures in a range of other countries during the earlier parts of the global financial crisis.

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